ASTROBIOLOGICAL ASPECTS OF RADIATION CHEMISTRY ON EUROPA

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Europa's surface composition is profoundly influenced by bombardment of energetic particles from Jupiter's magnetosphere. Radiolysis produces thermodynamically disequilibrium molecules that may be used by organisms in energy-producing reactions, forming a radiation-driven ecosystem as hypothesized by Chyba (2000); Chyba and Hand (2001); Chyba and Phillips (2001). One part of this three-year effort is to experimentally determine the disequilibrium chemicals that are produced by high-dose irradiation of ice containing impurities relevant to Europa.

The second part of this work studies the radiolytic modification of chemical biosignatures. A prime goal for an astrobiology mission landing on Europa is determination of the chemical composition of the surface and subsurface, searching for complex organic molecules that may serve as biosignatures. High-energy radiation decomposes molecules on Europa, even to depths of about a meter. Determining the depth required for obtaining useful biosignature molecules requires a systematic study of candidate molecules, irradiated in ice at Europa-like temperatures.

Samples are prepared by vapor deposition of gaseous mixtures or directly frozen from liquid solutions. Electrons are the major radiolyzing energy source at Europa and we use 5-keV to 100-keV electrons to simulate Europan conditions. Irradiations are performed at various temperatures including Europa-like temperatures, typically 80 to 120 K. Chemical evolution of the samples is determined using infrared spectroscopic measurements and mass spectroscopy, both obtained throughout the exposure and during subsequent temperature-programmed desorption.

Most of our work to date has been devoted to the production of disequilibrium molecules (such as oxidants) from pure water ice and ice with relevant impurities (e.g., CO_2, SO_2, O_2; see Figure). Results from these irradiations will be summarized, and preliminary results on the radiolytic degradation of chemical biosignatures will be presented.

Chyba, C. F. 2000. Energy for microbial life on Europa. *Nature* **403**, 381-382.
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Chyba, C. F., and C. B. Phillips 2001. Possible ecosystems and the search for life on Europa. *Proc. Nat. Acad. Sci.* **98**, 801-804.